Artificial and Computational Intelligence

AIMLCZG557

BITS Pilani

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AIMLCZG557 – CS#1

M1: Introduction to AIMLCZG557 & AI

ACI: Disclaimer and Acknowledgements

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- Few content for these slides may have been obtained from prescribed books and various other source(s) on the Internet.
- We hereby acknowledge all the contributors for their material and inputs and gratefully acknowledge people others who made their course materials freely available online. We have provided source information wherever necessary.
- We have added and modified the content to suit the requirements of the class dynamics & live session's lecture delivery flow for presentation.
- This *is not a full-fledged* reading materials. Students are requested to refer to the textbook w.r.t detailed content as per the course handout as shared over e-learning portal - Taxila.
- **Slide Source / Preparation / Review:**
- From BITS Pilani WILP**:** Prof. Rajavadhana, Prof. Indumathi, Prof. Sangeetha and Prof Parthasarathy PD
- From BITS On-campus & External : Mr.Santosh GSK

Agenda for CS #1

1) Introduction to AIMLCZG557
   - Course handout
   - Books & Evaluation components
   - How to make the most out of this course ?
2) History of AI
3) Foundations & applications & Risks of AI
4) Perspectives to Artificial Intelligence (AI)
5) Agents and Introduction to PEAS
6) Q&A!

Course Handout

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Birla Institute of Technology & Science, Pilani
Work Integrated Learning Programmes Division

Digital Learning Handout

Part A: Content Design

Course Title	Artificial and Computational Intelligence
Course No(s)	AIML ZG557
Credit Units	5
Credit Model	1.25 - 1.5 - 2.25
Course Author	Profs. Vimal SP, Raja Vadhana Prabhakar
Instructors	Prof. PD Parthasarathy, Prof Akhil PV, Prof A Raghunathan, Prof Arunkumar B, Prof Shyamala Boosi, Prof Sudheer Reddy, Prof Ramya Devi M, Prof Sandeep Patil, Prof SURYA PRAKASH Goteti
Version No:	6.0
Date:	30/03/2026

Course Description:
Agents and environments, Task Environments, Working of agents; Uninformed Search Algorithms: Informed Search. Local Search Algorithms & Optimization Problems: Genetic Algorithm; Searching with Non-Deterministic Actions, Partial Information and Online search agents, Game Playing, Constraint Satisfaction Problem, Knowledge Representation using Logics: TT-Entail for inference from truth table, Proof by resolution, Forward Chaining and Backward Chaining, Inference in FOL, Unification & Lifting, Forward chaining, Backward Chaining, Resolution; Probabilistic Representation and Reasoning : Inference using full joint distribution, Representation of Conditional Independence using BN, Reinforcement Learning; Difference between crisp and fuzzy logic, shapes of membership function, Fuzzification and defuzzification, fuzzy logic reasoning; Decision making with fuzzy information, Fuzzy Classification; Connectionist Models: Introduction to Neural Networks, Hopfield Networks, Perceptron Learning, Back propagation & Competitive Learning, Applications of Neural Net: Speech, Vision, Traveling Salesman; Genetic Algorithms - Chromosomes, fitness functions, and selection mechanisms, Genetic algorithms: crossover and mutation, Genetic programming.

Course Objectives

No	Course Objective
CO1	Identify and recall fundamental concepts and techniques for designing intelligent agents
CO2	Represent and use of knowledge in inference-based problem solving approaches
CO3	Apply probability theory to describe and model agents operating in uncertain environments
CO4	Implement optimisation models of computation and processing in real world application of intelligent agents
CO5	Apply principles of cooperative and competitive multi-agent decision making by constructing conceptual frameworks

- Local Search Algorithms & Optimization Problems: Hill Climbing Search, Local Beam Search, Evolutionary Algorithm - Genetic Algorithm, Bioinspired Algorithm - Ant Colony Optimization
- Neural Architecture Search: Introduction, Neuro Evolution

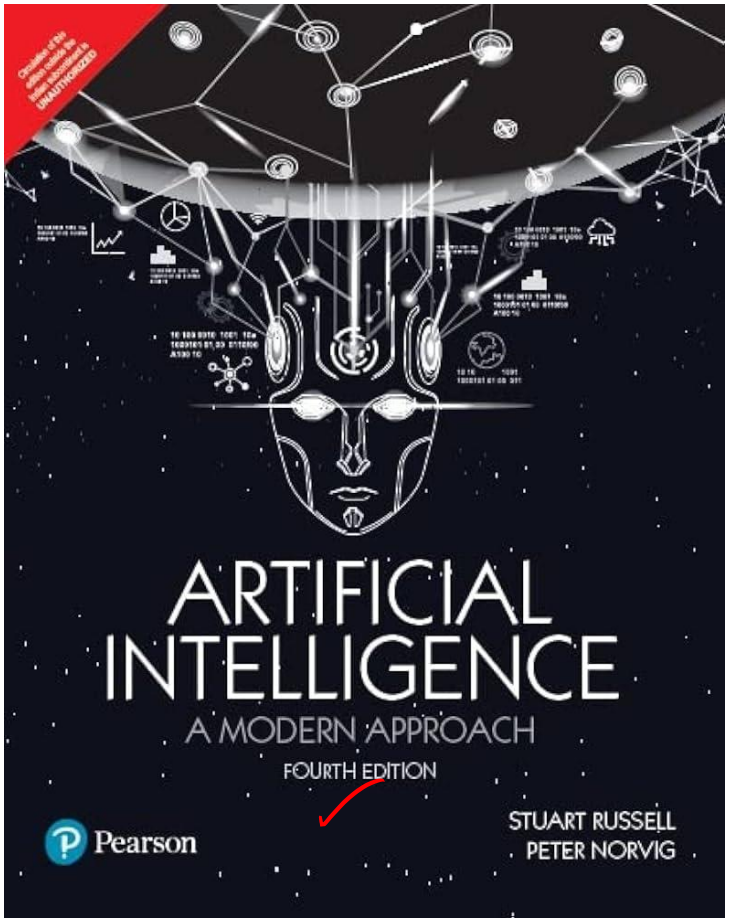
4. Game Playing:
   - Searching to play games: Minimax Algorithm, Alpha-Beta Pruning
   - Monte Carlo Tree Search
   - Stochastic Games
5. Knowledge Representation using Logics:
   - Overview of Logics- Propositional, Predicate, TT-Entail, Theorem Proving
   - Logic Representation of a sample agent, Proof by resolution, DPLL Algorithm, Agents based on Propositional logic
   - Unification, forward chaining, Backward Chaining, Resolution
6. Multi agent Decision Making:
   - Multi agent Planning: Properties of Multi agent environments
   - Non-Cooperative Game Theory
   - Cooperative Game Theory
   - Making Collective Decisions
7. Probabilistic Representation and Reasoning
   - Representing Knowledge in an Uncertain Domain
   - The Semantics of Bayesian Networks
   - Exact Inference in Bayesian Network
   - Approximate Inference in Bayesian Networks
8. Probabilistic Reasoning over time
   - Time and Uncertainty
   - Overview of inference in Temporal Models - Hidden Markov Models - Learning HMM
   - Dynamic Bayesian Networks
9. Ethics in AI
   - Explainable AI- Logically Explained Network, Explainable Bayesian Network

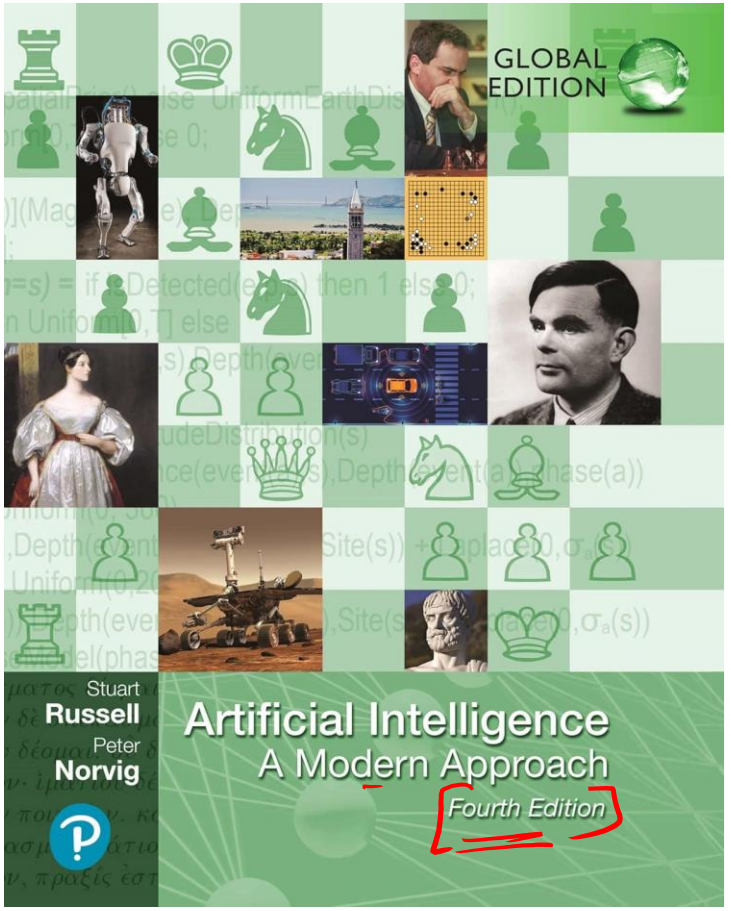
Part B: Learning Plan

Contact Session	List of Topic Title	Sub-Topics	Reference
1-a)	**Introduction**	• What is Artificial Intelligence: Acting Humanly, Thinking humanly, Thinking rationally, Acting Rationally • Foundations of AI , Brief Overview of Modern AI & Application Domains.	T1: 1.1 T1: 1.2, 1.4, 1.5
1-b)	**Introduction to Intelligent Agents**	• Intelligent Agents: Notion of Agents and Environments,	

Available in eLearn Course homepage: Course Handout

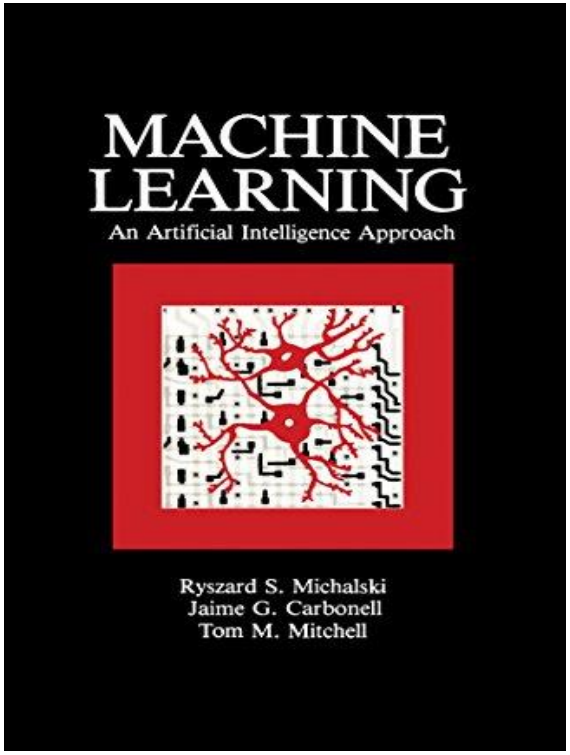
Text Book



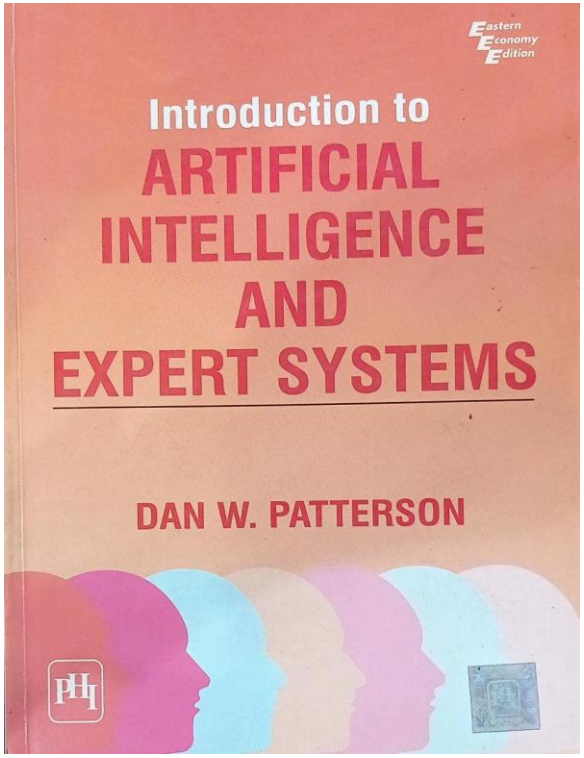


T1: Stuart Russell and Peter Norvig, "*Artificial Intelligence – A Modern Approach*", **Fourth** Ed, Pearson Education, 2022

Reference Books

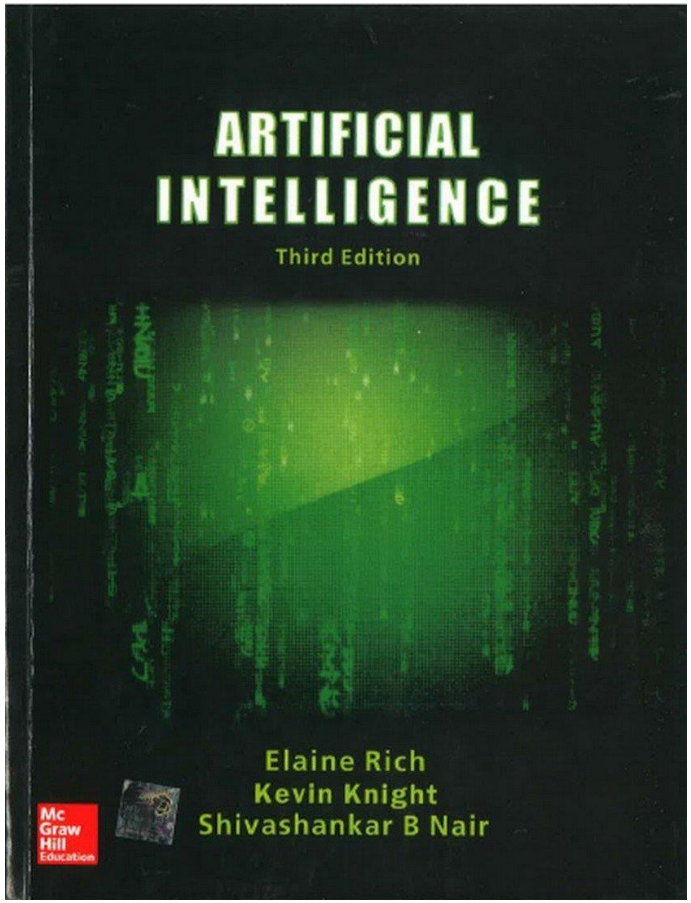


R1: Ryszard S. Michalski, Jaime G. Carbonell and Tom M. Mitchell, "*Machine Learning: An Artificial Intelligence Approach*", Elsevier, 2014



R2: Dan W Patterson, "*Introduction to AI and Expert Systems*", Prentice Hall of India, New Delhi, 2010

Reference Books



R3: Elaine Rich and Kevin Knight, Shivashankar B Nair, "*Artificial Intelligence*", 3rd Ed, Tata McGraw Hill Publishing Company.

Evaluation Components

- EC1: Continuous assessment (**30marks**)
  - Assignment 1 – 12marks (Before mid-semester exam)
  - Assignment 2 – 13marks (After mid-semester exam)
  - Quizzes (Best of 2) – 5marks (1 before and 1 after mid-semester)
- EC2: Mid-semester examination (**30marks**)
  - Topics covered from CS#1 to CS#8
- EC3: Comprehensive final examination (**40marks**)
  - Topics covered from CS#1 to CS#16

Watchout for TAXILA announcements for evaluation dates. No extension on deadlines will be entertained.

Ground Rules!

- Be Regular 😅
- Mentally present – Observe!! Listen!! 😉
- Keep your questions for the Q&A section …
- Use the Discussion Forum in Taxila effectively
- Solve the exercises regularly!
- Go an extra mile ☺

$$1^{365} = 1$$

$$1.01^{365} = 37.8$$

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Pre-requisites for this course ?

Class Requirements:

- Uses a variety of skills / knowledge:
- Probability and statistics
- Boolean logic
- Algorithms
- Above average coding skills (Python, Prolog)

Official Pre-requisites:

- Data Structures

Unofficial Pre-requisites:

- Willingness to learn whatever background you are missing 😉

What is this course about ?

Focus on:

- Philosophy of Artificial Intelligence (AI)
- Introduction to '*breadth*' of ideas/concepts in AI
- Principles of artificial intelligence
- Concepts, and algorithms involved in building rational agents
- Topics covered like:
  - (informed, uninformed & local) search & optimizations & applications
  - (logical & probabilistic) knowledge representation
  - (logical & probabilistic) Reasoning & applications
- a bit of learning (reinforcement learning)
- a bit of *ethics* in AI

What is this course *not* about ?

- Hardware aspect of design
- Formal introduction to machine learning algorithms, neural networks etc., are covered as a ML course is running in parallel, Deep neural networks, which are part of AI as well.
- Deeper applications & algorithms of application of AI in Computer Vision, Natural Language.
- While we talk about rational and various types of agents in this course. This is NOT a course on Agentic AI (MCP, LLMs, Tool Calling etc.)!

Andragogy / Pedagogy

- Weekly online live sessions (with recordings).
- Four Webinars (with recordings) on lab implementation and problem solving.
- Lab Modules: Self practice lab capsules for practical implementation and better understanding of concepts learned in live lectures available via virtual lab.
- Learning is a social activity. Peer to Peer interaction and learning is very important, particularly in WILP setting:
  - Weekly "Think" topics posted on Taxila in Discussion for students to think, discuss in the forum.
  - This will be used to calculate "engagement" points and a leaderboard will be created.
  - At the end of the semester, the top 'k' members of the leaderboard will receive non-academic surprise! Maybe an AI comic? AI book? An opportunity to work on a research project with a BITS faculty? Or watch an AI sci-fi movie!

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S_1 : No Data
No map →

① Agent → memory → KB
② Explore all possible path
③ Environment → map
④ Sensor → I/P → percept
⑤ Actuator

S, ① No map → KB
② Certain
Static

Actions
↳ {MU, MD, ML, MR, ABreak}

S, MR → J1 fact

⑦ Initial State : Source

J1, MR → DE f2

J1, MU → J2

Destination - Fixed Goal

S, MR → J1

⑧ Transition Model

J1, MR → DE
J1, MU → J2

⑨ random

⑯ Learn info
↓
FACT
↓
KB

⑪ Backtracking

⑫ visited state

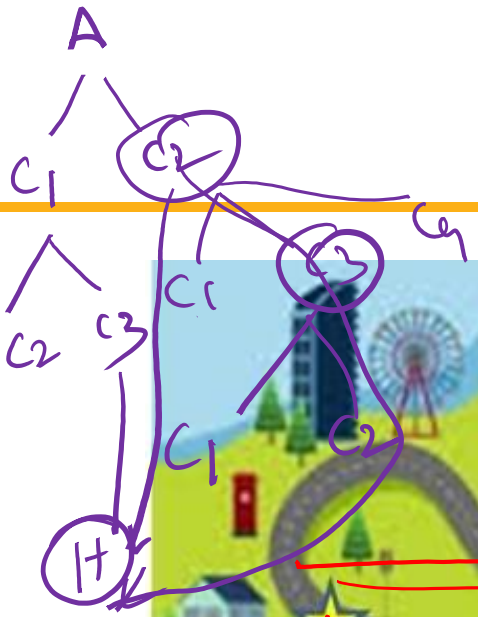
S, J1, J2, J3, J4

A - BST → BJ2

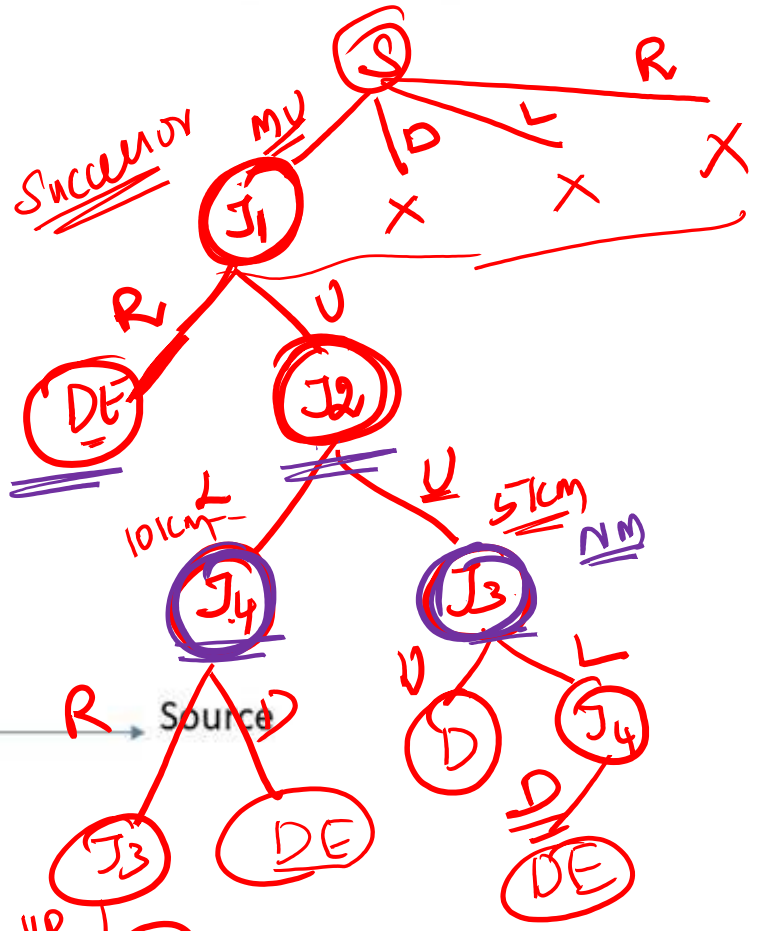
Destination - Fixed Goal
Source

State Space transition Diagram or Search Tree

Is: S, Action, MU, MD, ML, MR



Destination - Fixed Goal



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Sol:- P1 P2

① Performance measure → Numerical Measure → Utility value

Path cost - + additive

① Distance, time, cost, Quality, # traffic signs

Obj
- max : quality, fuel eff
- min : time, dist, cost, traffic

fuel eff

—x—

Destination - Fixed Goal
Source

Uncertain

S2 : (S,D) → P1, P2

S1 : KB

KB Dynamic

(S Route)

KB
J2-J3
J1 R→DE

J3 Failed

KB

J2 - J3 → Remove

Retain yes

Prob

P1 → S-J1-J3 → D (15km)

P2 → S-J1-J2-J4-J3-D (20km)

P(P2) ⇒ 0.8

P(P1) ⇒ 0.2 → 0.8

PS → Solu

↓

AI solution

(IS, A, PC, TF, G) ✓ ST

Search → soln

m2 → m3 search ✓ soln

m4 Game

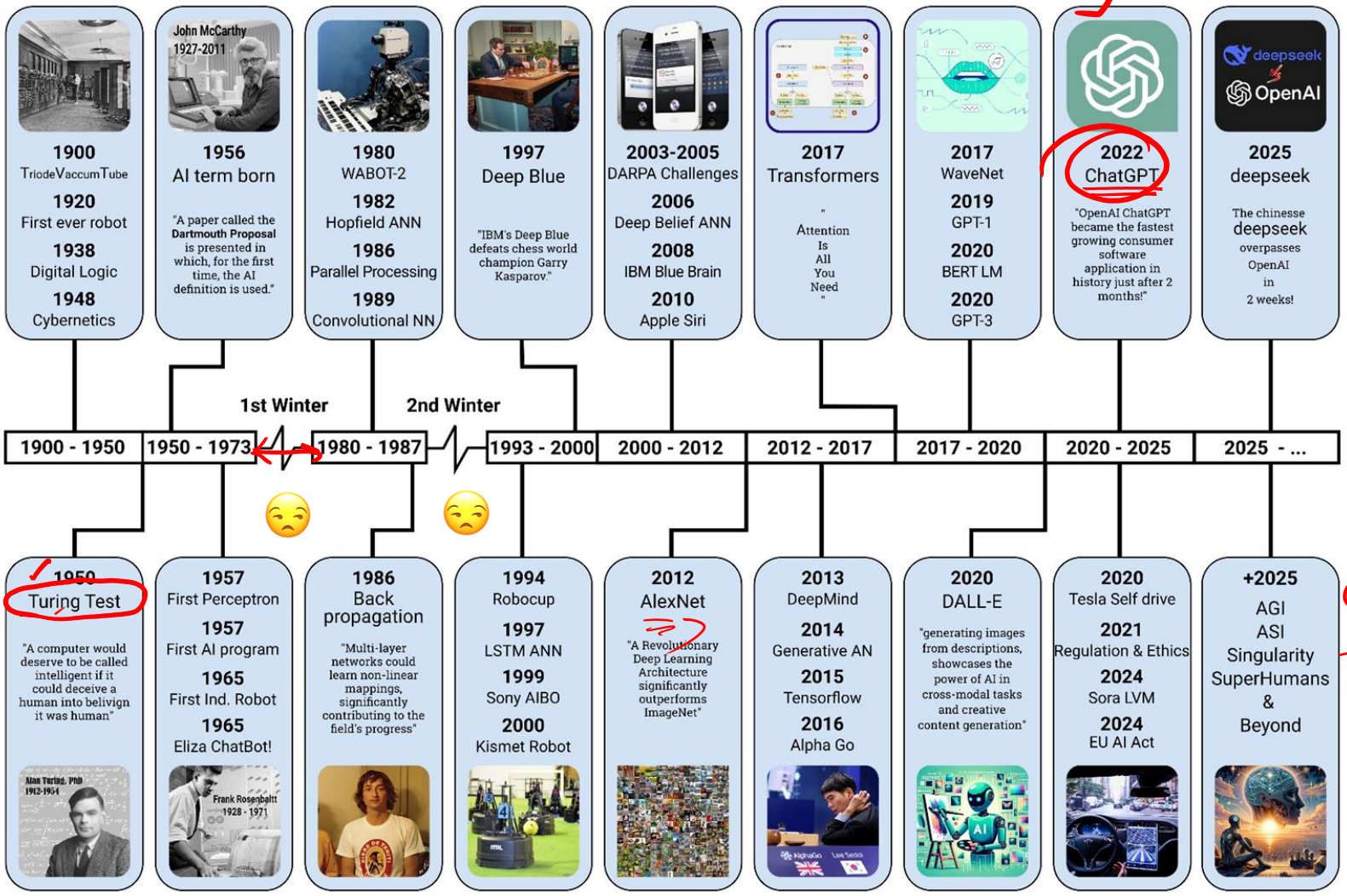
m5,6 knowledge → fact → KB → Inferen

↳ Logic

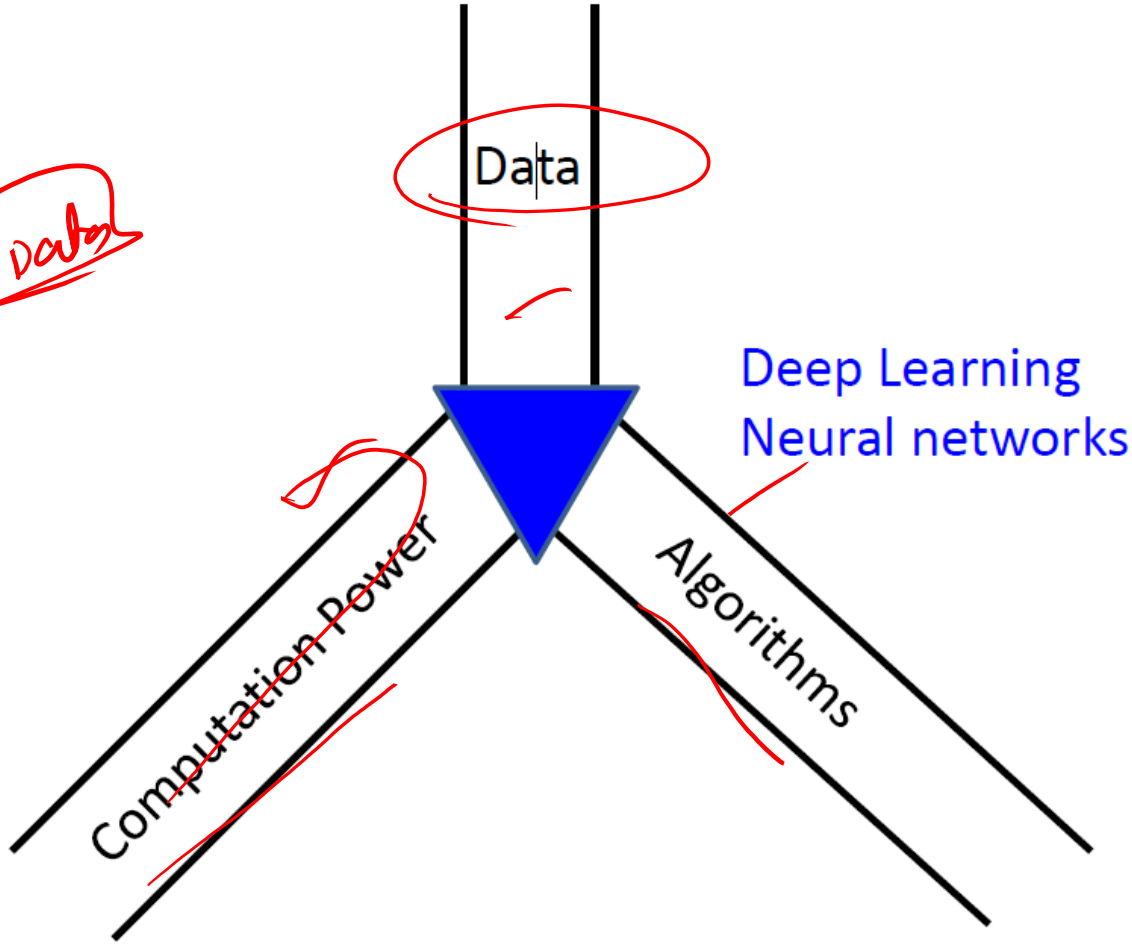
↳ prob

m,8,

History of AI



What Changed in the last Decade?



Thank You for your time & attention !

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